Research on the Teaching Reform of "Civil Engineering Experiment" under the Background of Emerging Engineering Education

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Abstract: At this stage, against the social backdrop of industrial transformation and the scientific and technological revolution, the concept of Emerging Engineering Education (EEE) has been widely applied in the teaching of various engineering disciplines. In the experimental teaching link of the civil engineering discipline, it is also necessary to actively strengthen the construction of EEE, follow the teaching principles such as innovative talent training and cross-border integration of teaching resources, and realize profound teaching innovation and transformation to adapt to the industrial development needs of information technology application, green building, intelligent manufacturing and so on. Thus, research on the teaching reform of civil engineering experiments within the EEE framework has gained increasing attention. Based on this, this paper briefly analyzes the demand for civil engineering talent training based on EEE, and deeply discusses the relevant problems and teaching strategies of engineering experiment teaching for reference.

Keywords: Emerging Engineering Education; Civil Engineering; Civil Engineering Teaching

DOI:10.12417/3029-2328.26.03.024

Introduction

In recent years, the continuous development of fields such as transportation, architecture, water conservancy and environment has promoted the teaching reform of civil engineering, and the relevant reform concepts have been upgraded accordingly. However, according to practical research, some schools have the problem of insufficient integration of the concept of EEE when carrying out the teaching reform of civil engineering experiment courses, which affects the reform effect. As a result, the reformed civil engineering experiment teaching cannot meet the latest industry and social development requirements. To change this situation, this paper focuses on carrying out the teaching reform of civil engineering experiment under the background of EEE for in-depth research.

1.New Requirements of EEE Construction for Civil Engineering Talent Training

Presently, international and relevant education departments have clearly put forward the requirements for the construction of EEE to ensure the quality and level of engineering education. Under this background, in the teaching and talent development of civil engineering, it is necessary to take promoting the innovation of civil engineering, accelerating the technological innovation of the civil engineering industry and civil engineering experiments as the main teaching and talent training objectives, ensure that they meet the actual civil engineering needs and the rapidly changing talent needs of the industry and society, and provide high-quality talent support for the sustainable development of modern scientific and technological innovation and manufacturing industry. In addition, talent training should be in line with the latest development strategic goals such as innovation-driven development and strengthening the country through talents, and educational goals should be consistent with the requirements put forward by the high-tech industry for higher education.

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Funding:Educational and Scientific Research Projects for Young andMiddle-aged Teachers of Fujian Province (Science and Technology Category)(NO. JZ240069); Fujian Provincial Natural Science Foundation of China (NO. 2024J01844 and NO. 2025J011696); Doctoral Support Program of Longyan University (NO. 0000290612)

2.Main Problems in Civil Engineering Experiment Teaching

2.1 Stagnant and Lagging Experimental Content

The update speed of civil engineering experiment courses in some schools is slow, resulting in rigid and outdated teaching content. Many institutions still focus on traditional content such as building construction and production manufacturing processes, lacking emerging topics in digital and intelligent construction, low-carbon and environmental protection infrastructure. Additionally, some universities offer emerging content as optional rather than compulsory courses, hindering the development of students' modern civil engineering skills and thinking. The experimental content also lacks sufficient cross-disciplinary integration with fields such as environmental engineering, automatic control, and computer modeling, leaving students without the interdisciplinary thinking required by EEE for compound, high-quality talent training. Furthermore, some schools inadequately integrate theoretical and practical teaching, focusing primarily on theoretical knowledge while failing to establish specialized practical content for complex problems in civil engineering.

2.2 Single and Passive Teaching Mode

Some schools still adopt the traditional teaching method of "teachers teach and students learn", resulting in a single teaching form and students being in a passive position in teaching, which affects the teaching quality and efficiency. For example, some schools adopt the traditional teaching method combining teacher's lecture with slide demonstration and blackboard writing demonstration, and fail to comprehensively adopt various teaching modes such as problem-oriented, situational introduction, project-based teaching, differentiated teaching and case teaching to explain civil engineering experiment cases in real scenarios in detail to students, guide students to actively explore cases, design learning projects, analyze what they have learned and acquire knowledge and skills. The overall teaching mode is teacher-centered, and students often have to passively accept knowledge. The awareness of interactive communication between teachers and students is poor, which leads to the teaching failing to meet the diverse learning needs of students and restricting the cultivation of students' comprehensive practical ability.

2.3 Scattered and Closed Resource Allocation

Civil engineering experiment teaching has the characteristics of strong practicality, wide coverage, and rapid update and upgrade of processes and knowledge. At present, the existing educational resources of some schools are not adapted to these characteristics, lacking top-level design for resource overall planning and integration and resource allocation, and having the problem of excessive scattered and fragmented resources. Moreover, insufficient attention is paid to school-enterprise cooperation and communication, the utilization of resources lacks openness and sharing and has the characteristic of strong closeness. The update speed of teaching resources is inconsistent with the new development requirements of the civil engineering industry under the background of EEE, and the channels to obtain the latest industry information are limited.

At the same time, some schools also have the problem of insufficient teaching resources in terms of teachers. The structure of the existing teaching team is unreasonable, some teachers lack professional teaching skills, literacy and experience in civil engineering experiments and the field of EEE. Moreover, some teachers focus their teaching work on the teaching process and fail to invest too much energy in teaching and research, teaching skill training and further study, which affects the diversified innovation of teaching modes, teaching concepts, students' teaching practice guidance and teaching curriculum design, thus affecting the practicality and professionalism of teaching.

3.Teaching Reform Strategies of Civil Engineering Experiment under the Background of EEE

3.1 Emphasizing Value Shaping in Experimental Content

3.1.1 Updating Experimental Projects

When reforming the teaching content of civil engineering experiments, the requirements of EEE construction can be considered to accelerate the content update and introduce more advanced experimental projects. Among them,

practical projects can be introduced, with civil engineering skills, conjecture and verification of experimental phenomena, innovation of theoretical knowledge, practice and solution of practical engineering problems, engineering investment evaluation, conception, implementation and project operation, quality acceptance and feedback as the main teaching content. On this basis, it is necessary to strengthen the modular design of the projects to meet different teaching needs, such as theoretical module, skill module, industry development module and talent training module. Considering the teaching mode, project-based experimental learning modules mainly based on group cooperation mode can also be set up. Members of each group need to cooperate to design project content, complete project tasks in the form of design, research, investigation, interview and achievement display, generate experimental project reports, analyze and summarize learning deficiencies, and make targeted improvements in a timely manner.

3.1.2 Adding Comprehensive Design Experiments

EEE requires the comprehensive development of civil engineering teaching. In the experimental teaching reform, highly comprehensive experimental projects can be introduced. Taking the teaching of civil engineering material experiments as an example, in terms of theoretical knowledge, comprehensive design experiments such as material preparation technologies and methods, material properties and essential characteristics, and material application can be added, with attention paid to the quality of experimental materials. Enable students to master the good control and evaluation of material quality during material preparation, guide students to be familiar with the basic properties of materials, deeply understand the detection methods of the main civil engineering material properties, and carry out material selection and design in accordance with appropriate principles. In terms of skills, comprehensive design experimental teaching content such as tool operation skill training, material technology application skill learning, experimental practice and basic practical ability cultivation can be added. Students can carry out experimental detection of sand, concrete, cement and other materials synchronously in class, including non-destructive testing technology, performance detection and compressive strength test.

3.1.3 Introducing Real Engineering Projects

To ensure that teaching is in line with the construction of EEE and social talent needs, the experimental content of civil engineering needs to be highly realistic. Teachers can design experimental project content by integrating the concept of curriculum ideological and political education, taking ideology and politics as the link between teaching content and real social scenarios. For example, in the practice of curriculum ideological and political education, teachers can introduce projects that introduce the important role of civil engineering in transportation power and new infrastructure, fully present China's major civil engineering achievements, and enable students to have a profound understanding of the real application methods and importance of civil engineering experiments in the industry and society. To further ensure the authenticity of experimental project content, teachers can also strengthen the construction of experimental carriers and build suitable laboratories. Based on innovative management, formulate unified experimental standards and experimental area management standards, make full use of advanced experimental instruments and equipment, build an online experimental platform, combine it with an offline open laboratory, manage the whole process of experimental reservation, operation and summary, and ensure that the online and offline laboratories give full play to their real effects in civil engineering scientific research, teaching, social services and other aspects.

3.1.4 Constructing a Step-by-Step Project Chain

Civil engineering experiments have the characteristics of strong logic and operability. When reforming the experimental content, more coherent progressive and step-by-step experimental project content can be introduced. For example, teachers can gradually construct a step-by-step project chain of theory, technology, practice and innovation in consideration of the construction needs of EEE and the green and information development needs of the civil engineering industry. In the theoretical project chain, on the basis of the traditional theoretical knowledge

teaching content such as structure, design and mechanics, advanced theoretical knowledge such as digital and automatic construction can be added to further improve the civil engineering knowledge system. In the technical project chain, rich interdisciplinary optional course content can be added, such as industrial robots, prefabricated construction, neural network monitoring of civil engineering surveying and mapping, to synergistically improve students' practical ability and interdisciplinary thinking. The practical project chain can be combined with talent training work, and experiments can be implemented throughout the whole life cycle of talent training, making experiments the core carrier of talent training. In the final link of the step-by-step project chain, the innovative project chain can adopt a mode combining industry, university and research or industry, university and teaching. Schools can cooperate with excellent industry enterprises to jointly cultivate students' knowledge and skills of civil engineering experiments.

3.2 Realizing Diversified Innovation in Teaching Mode

3.2.1 Independent Inquiry Experiments

Considering the dominant position of students, in the innovation of civil engineering experiment teaching mode, students' ability of independent inquiry learning can be cultivated. Teachers can add innovative and research-oriented experimental projects, guide students to independently create experimental topics, content and tasks, and then use the learned knowledge to complete experimental inquiry from different angles. At the same time, teachers can adopt literature investigation type experimental projects, where students independently search for materials, understand historical experimental data, current research status of experiments and experimental achievements, and comprehensively cultivate students' abilities of text sorting, problem finding and solving.

3.2.2 Immersive Teaching Practice

With the support of intelligent information technology, teachers can use technologies such as intelligent algorithms, augmented reality, virtual reality and deep learning to strengthen immersive experimental teaching. Present complex and abstract experimental phenomena, knowledge and processes vividly and intuitively in the form of audio and video, animation, images, etc., to assist students in better understanding the experimental content, principles and essential characteristics. Moreover, students can carry out high-risk experiments in the online virtual environment to improve the safety of experiments.

3.2.3 Online and Offline Hybrid Teaching

The above online experimental projects can also be integrated with offline classroom teaching to realize hybrid teaching. In the pre-class link, teachers can first use the online smart teaching platform and mobile learning devices to guide students to preview the experimental teaching content. Then in the teaching link, provide targeted teaching guidance according to students' preview situation, so that students can have a preliminary understanding of the experimental principle content before class, and then further deepen their understanding in class. At the same time, students can also independently complete online and offline hybrid learning after class, and use the consulting and feedback function of the online platform to provide support for offline consolidation of learning content.

3.2.4 Competition-Driven Mode

In the reform of teaching practice activity modes, teachers can organize discipline competitions, take teaching activities and experimental content as the foundation, provide innovative driving force for teaching through discipline competitions, and attract social enterprises to participate in the competitions, provide a large number of high-quality competition resources and equipment, and carry out collaborative teaching of education, competition and enterprise. After knowledge integration and operation skill training, organize students to participate in competition activities related to the industry field to cultivate students' ability to solve practical problems and innovate practice in civil engineering. Enrich the competition forms through advanced competition equipment and real engineering cases, guide students to accumulate experience, improve their abilities and literacy, and realize the

effective connection between the cultivation of civil engineering experiment talents and industrial needs.

3.3 Implementing Open Integration of Teaching Resources

3.3.1 Building a Multidisciplinary Comprehensive Experimental Center

To meet the needs of EEE for cultivating compound talents, in the innovation of civil engineering experiment teaching resources, knowledge and skills of different disciplinary fields can be integrated to specially build a multidisciplinary cross-integrated teaching resource system. For example, in civil engineering material experiments, knowledge of the biological field can be integrated, and culture media can be prepared by mixing raw materials such as distilled water and yeast in an appropriate proportion. Then make concrete test pieces, grind them into powder, and treat the powder with biological technologies such as antibacterial test, standard sieve sieving and high-temperature sterilization. Finally, mix the powder with the culture medium, observe the antibacterial situation of the culture medium in the future period of time, and check whether the antibacterial ability is qualified. In the concrete material performance experiment, knowledge of physics and architecture can be integrated to judge whether the concrete strength is up to standard in the form of non-destructive testing, slump test, impact resistance test and so on.

3.3.2 Virtual Simulation Experiment Platform

After integrating online educational resources, a special virtual platform can be built to store resources and provide support for offline experimental teaching. Resources can be used to create different functional modules on the platform to meet diverse teaching needs. For example, a virtual simulation integration module of architecture and intelligent technology can be set up to provide students with a virtual experimental environment that highly simulates and restores real architectural scenes in life for various architectural experiments. Students can simulate the management requirements of architectural design and construction sites, improve their practical ability in intelligent building construction management, and fully clarify the management requirements, processes, objects and standards. At the same time, a sound virtual simulation experimental teaching system can be established on the platform. For example, teachers can set up virtual teaching experimental projects based on the characteristic advantages of the civil engineering discipline and the regional characteristics of the school's location to cultivate students' innovative ability, comprehensive learning ability and thinking ability. In addition, relying on school-enterprise cooperation, the platform can be used to carry out virtual simulation experimental teaching of civil engineering technology, giving play to the platform's leading and exemplary role in teaching.

3.3.3 Digital Management System

In addition to intelligent virtual simulation teaching resources, in the teaching reform of civil engineering experiments, teaching resources in the form of digital information technology can also be introduced to establish a teaching system to assist in improving the level of teaching management. The digital management system can be integrated with the problem-oriented teaching mode to design interesting teaching problems, stimulate students' interest in experiments and trigger students' thinking about practical civil engineering problems. At the same time, the digital management system can also be used to manage teaching evaluation, carry out evaluation and assessment focusing on teaching process and teaching innovation, and design multiple assessment indicators such as creative thinking, interactive communication, experimental process and knowledge application ability. For example, in interactive evaluation, a variety of digital technologies such as digital twin, blockchain, Internet of Things, human-computer interaction and voice interaction can be used, and evaluation methods such as group mutual evaluation, public speech and display of experimental works and achievements, and teaching and research by multidisciplinary teachers can be adopted, which is conducive to cultivating students' awareness of learning cooperation and initiative.

4.Conclusion

To sum up, the construction quality of EEE directly affects the overall teaching quality of civil engineering experiment courses. It is necessary to focus on the demand for civil engineering talent training from the perspective of EEE, combine the existing teaching problems in the experimental content, mode and resources of civil engineering, and adopt strategies such as constructing a step-by-step project chain, immersive teaching and building a virtual simulation experiment platform to ensure the smooth development of all civil engineering experiment teaching work under the background of EEE.

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